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RADIATION SAFETY OF CREW AND PASSENGERS OF AIR TRANSPORTATION IN CIVIL AVIATION. PROVISIONAL STANDARDS

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Translation of "Radiatsionnoy Bezopasnosti Letnogo Personala i Passazhirov Vozdushnogo Transporta Grazhdanskoy Aviatsii, Vremennyye Normy," (VNRBGA-75), Ministry of Health USSR, Moscow, 1975, pp 1-17.

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16. Abstract

The purpose and application of the provisional standards for radiation safety of crew and passengers in civil aviation are given. The radiation effect of cosmic radiation in flight on civil aviation air transport is described. Standard levels of radiation and conditions of radiation safety are discussed.

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RADIATION SAFETY OF CREW AND PASSENGERS OF AIR TRANSPORTATION IN CIVIL AVIATION.

PROVISIONAL STANDARDS

I. INTRODUCTORY SECTION

1.1. Purpose and sphere of application. /3

1.1.1. These standards apply to all air transport means of the Ministry of Civil Aviation intended for transporting passengers and cargo at flight levels. above 12,000 meters.

Note. The natural fund of external radiation at altitudes up to 12,000m creates an annual equivalent dose of no more than 0.5 rem with flight not exceeding 1,000 hours per year.

1.1.2. The provisional standards for radiation safety of flight crew and passengers of air transportation in civil aviation (VNRBGA-75) regulate the effect of all radiation factors occurring during flights on the crew and passengers.

1.1.3. These standards are applicable to the following categories of irradiated persons:

-- flight personnel;

-- passengers.

1.1.4. The basis for these provisional standards are the materials of the National Commission for Radiation Protection of the USSR Ministry of Health. The following sources were used in developing the VNRBGA-75:

a) Materials of the International Commission on Radiation Protection (ICRP)

-- publications 9, 21, 22;

-- recommendations "Radiation Effect in Flights of High-Altitude Airplanes".

b) Materials of the International Organization on Civil Aviation (ICAO):

-- recommendations of the fifth conference of the group of experts on the operation of high-altitude transport means (HTM) on the question of cosmic radiation (points 1 and 2 of the agenda).

c) The "Statement on Flight and Ground Research for the Purpose of Working Out Predictions and estimations of the Radiation Conditions Along Routes and HTM Flight Altitudes". GOSNIIGA [State Order of the Labor Red Banner Scientific-Research Institute on Civil Aviation], Moscow, 1974. /2

d) "Radiation Safety in Flights of High-Altitude Airplanes", Ye. Ye. Kovalov, V.M. Petrov, Zhurnal Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Space Biology and Aerospace Medicine), Vol. 9, No. 2, 1975, 54-59

e) System of Labor Safety Standards, GOST (State Standards) 12.0.001-74, 12.0.002-74, 12.0.003-74.

1.1.5. The responsibility for fulfilling these standards is placed on the management and the responsible parties at the Ministry of Civil Aviation and its subordinate administrations, enterprises and subdivisions.

1.2. General concepts, terms and definitions.

1.2.1. Ionizing radiation -- any radiation whose interaction with the environment leads to the formation of electric charges of different signs.

Note. a) ultraviolet radiation and visible light are not related to ionizing radiation;
b) subsequently, the term radiation is also used here as a shortened form.

1.2.2. Gamma-radiation — electromagnetic (photon) radiation with discrete spectrum emitted in nuclear transformations or in particle annihilation.

1.2.3. Corpuscular radiation -- ionizing radiation consisting of particles (electrons, protons, neutrons, alpha-particles, etc.).

1.2.4. Linear transmission of energy of charged particles in the environment (LTE) -- the average energy $d\bar{E}$ lost by a particle in the environment due to co-impacting, with transmission of energy less than Δ ev on a small segment of path dl, divided by this segment:

$$L_\Delta = \left(\frac{d\bar{E}}{dl}\right)_\Delta$$

The LTE unit of measure is the kiloelectron volt per micron of water, 1 keV/μ m = 62.5 J/m.

1.25. Absorbed dose D -- the average energy dE, transmitted by the radiation to a substance within a small volume element, divided by the mass of the substance dm in this volume

$$D = \frac{d\overline{E}}{dm}$$

1.2.6. Rad -- special unit of absorbed dose. /5

$$1 \text{ rad} = 100 \text{ erg/g} = 1.10^{-2} \text{ J/kg}$$

1.2.7. Capacity of absorbed dose P -- growth in absorbed dose dD over a short time interval dt, divided by this interval

$$P = \frac{dD}{dt}$$

A special unit of capacity of absorbed dose is the rad per second, 1 rad/sec.

1.2.8. Equivalent dose H -- derivative of the absorbed dose D to the average coefficient of the quality of radiation KK in the given point of tissue:

$$H = D \cdot \overline{KK} = D_1 (KK)_1 + D_2 (KK)_2 + D_3 (KK)_3 + \ldots = \int_0^\infty D(L_\infty) KK(L_\infty) dL_\infty$$

where indices 1, 2, 3,... relate to the components of radiation with different quality:

$$D_1 + D_2 + D_3 + \ldots = D$$

$D(L_\infty)$ -- the distribution of the dose along the full LTE;

KK (L_∞) -- the regulated dependence of the coefficient of quality on the full LTE.

Notes. a) the dimensionless coefficient of quality KK determines the dependence of unfavorable biological consequences of irradiation of man in small doses on the full radiation LTE. The regulated dependence KK(L_∞) is presented in Table 1.1

Table 1.1.

keV/ μm water	35	7.0	23	53	157
KK	1	2	5	10	20

b) $\overline{KK} = \frac{D_1(KK)_1 + D_2(KK)_2 + D_3(KK)_3 + \ldots}{D} = \frac{1}{D}\int_0^{\infty} D(L_\infty)KK(L_\infty)dL_\infty$

c) the capacity of the equivalent dose is determined analogous to the capacity of absorbed dose (term 1.2.7).

1.2.9. Rem -- special unit of equivalent dose. /6

$$1 \text{ rem} = \frac{100 \text{ erg/g}}{KK} = \frac{1 \cdot 10^{-2} \text{ J/kg}}{KK}$$

1.2.10. External radiation -- the effect of ionizing radiation on the organism from external radiation sources.

1.2.11. Natural fund of radiation -- ionizing radiation consisting of cosmic radiation and radiation of naturally distributed natural radioactive substances (on the earth's surface, in the earth's atmosphere, in food products, water, in the human organism, etc.).

1.2.12. Source of radiation -- substance or device emitting or capable of emitting ionizing radiation.

1.2.13. Flight personnel -- persons for whom participation in flight is an occupational activity.

1.2.14. Passengers -- persons participating in flight who are not flight personnel.

1.2.15. Radiation safety -- exclusion of somatic effects in flight personnel and passengers subjected to radiation effect and limitation of risk of long-term somatic-stochaistic and genetic consequences to a socially acceptable level.

1.2.16. Condition of radiation safety -- maintaining standard levels of:

-- maximally allowable doses for flight personnel;

-- dosage limits for passengers.

1.2.17. Standard level -- annual dosage limit of radiation effect.

1.2.18. Appraisal of radiation safety -- complex of measures directed at establishing the correspondence of anticipated levels of radiation effect under standard conditions of operation of civil aviation air transport to the standard levels.

1.2.19. Maximum allowable dose MAD -- the greatest value of individual equivalent dose per year, which with uniform effect during the period of occupational activity will not cause unfavorable changes detected by modern methods in the state of health of the flight personnel.

1.2.20. Dosage limit DL -- maximal individual equivalent dose per year for passengers (limited portion of the population). The dosage limit is set at less than the MAD for the purpose of preventing unsubstantiated radiation of this contingent of persons.

1.2.21. Operating control level -- value of strength of equivalent dose established for operating control of the radiation environment for the purpose of informing flight personnel of its possible deterioration.

1.2.22. Level of taking measures -- value of strength of equivalent dose at which it is necessary to implement measures directed at preventing the disruption of the condition of radiation safety.

1.2.23. Flight time norm -- limit of annual flight time which is permitted in flight subsections in planning flights for crews of various types of aircraft.

1.2.24. Flight altitude -- relative barometric altitude computed from the level of isobar surface, corresponding to standard atmospheric pressure of 760 mm Hg column (1013 mb), allocated for aircraft flights and separated by established intervals.

2. Brief description of radiation effect of cosmic radiation in flight on civil aviation air transport.

2.1. General radiation sources.

2.1.1. Galactic cosmic radiation (GCR) is a constantly acting source. It consists generally of protons and alpha particles. The make-up of the GCR also includes heavy charged particles, up to iron nuclei.

2.1.2. Solar cosmic radiation (SCR) is generated during chromospheric flare-ups on the Sun, and consists generally of protons. This source bears a probable character.

2.2. Peculiarities of radiation effects.

The peculiarities of radiation effects during flights on civil aviation air transport are determined by the physical characteristics of the radiation and by the flight conditions.

The level of effect of GCR and SCR in the atmosphere is determined by two basic processes: the penetration of primary radiation to the flight altitude and the formation of secondary radiation in the atmosphere due to the interaction of GCR and SCR with oxygen and nitrogen nuclei. Secondary radiation /8 has a complex composition (neutrons, protons, mesons, electrons, and gamma-radiation). The most radiationally significant components are the neutrons, which possess a high penetrating capability and which give considerable input into the equivalent dose.

The permanently acting source (GCR) determines the gradual increase in the natural radiation background with increase in altitude from sea level to 20-24km, where the maximal level of secondary radiation is observed. With a further increase in the altitude to 30-35km, the radiation background is somewhat reduced and approaches the level of radiation in the cosmic space around the earth. The maximal value of strength of equivalent dose from GCR

in the atmosphere comprises around 2 mrem/hr.

The maximal level of solar cosmic radiation is observed at the boundary of the atmosphere and is reduced with increase in its thickness, since the process of weakening of the primary radiation prevails over the process of accumulation of secondary radiation.

A peculiarity of the radiation effect is also the latitudinal dependence of the level of radiation (especially solar cosmic radiation) conditioned by the geomagnetic field: the level of radiation in the region of the equator is several times lower than in the high latitudes.

The indicated specifics lead to the situation whereby at the altitude of flights by air transport the radiation effect is generally determined by the radiation with high penetrating capacity.

3. Standard levels of radiation effect

3.1. The categories of persons subjected to radiation effect.

3.1.1. In accordance with the standard levels, the following categories of persons who might be subjected to radiation effect during flights on civil aviation air transport are established:

-- flight personnel;

-- passengers.

3.2. Standard levels.

3.2.1. The following standard levels are established for the indicated /9 categories of persons:

-- maximum allowable dose for flight personnel;

-- dosage limit for passengers.

3.2.2. Established as the standard level for flight personnel is the value of marginally allowable dose, which is equal to 5 rem per year. Established

as the standard level for passengers is the value of the dosage limit, which is equal to 0.5 rem per year.

The indicated values of standard levels relate to uniform general radiation of the body.

Note. For women of child-bearing age (up to 40 years old) in the category of flight personnel there is an additional limitation of radiation effect: the equivalent dose in the area of the pelvis must not exceed 1 rem in any two months.

4. Ensuring conditions of radiation safety.

4.1. With radiation effect of galactic cosmic radiation and in the absence of solar cosmic radiation, the condition of radiation safety during flight of civil aviation air transport is ensured in relation to the flight personnel as well as in relation to the passengers.

4.2. The radiation effect of solar cosmic radiation may lead to a disruption of the condition of radiation safety in the flight of civil aviation air transport in regard to the flight personnel as well as in regard to the passengers.

4.3. In order to ensure conditions of radiation safety during flights of civil aviation air transport, it is necessary to:

-- predict the levels of radiation effect by solar cosmic radiation on the flight personnel and passengers;

-- implement radiation control by on-board means of air transport;

-- implement measures directed at reducing the levels of radiation effect on the flight personnel and passengers.

Note. The conditions of safety for transporting radioactive substances are regulated by the "Safety Regulations in Transporting Radioactive Substances PBTRB-73".

4.4. Predicting the levels of radiation effect of solar cosmic radiation /10 is done by the efforts of the All-Union Radiation Safety Service on the basis of information on the geophysical phenomena and on the radiation environment in the air space around the earth.

4.5. Radiation control on board the air transport is implemented for the purpose of:

-- determining the value of equivalent dose of radiation effect during the period of the flight;

-- obtaining operating information on the radiation situation on board the air transport during flight.

4.6. Measures directed at reducing the level of radiation effect on the flight personnel and passengers are implemented according to the results of prediction and on-board radiation control.

4.7. In case of disruption of the condition of radiation safety for the flight personnel, the level of radiation effect of no more than 2 MAD must be compensated in such a way that in the subsequent period, not exceeding 5 years, the accumulated equivalent dose does not exceed the value determined by the formula:

$$H = MAD \cdot T$$

where H is the equivalent dose of radiation accumulated during the time starting from beginning of occupational activity, rem;

MAD is the maximum allowable dose, rem per year;

T is the period from the start of occupational activity, years.

With a level of radiation effect of no more than 5 MAD, the radiation effect must be compensated so that in the subsequent period, not to exceed 10 years, the accumulated equivalent dose does not exceed the value determined by the formula indicated above.

4.8. With one-time radiation effect in a dose exceeding 5 MAD, the flight personnel must be sent in for medical examination. The flight personnel subjected to such radiation effect may be allowed to continue their routine work only in the absence of medical contraindications, with the condition that the following requirement is fulfilled:

$$H \leqslant MAD \cdot T$$

5. Radiation control on board air transport /11

5.1. During the flight, control must be implemented over the strength of the equivalent dose of radiation on board the air transport, as well as the equivalent dose of radiation effect on the flight personnel during the flight.

5.2. For operating control over the radiation situation for the purpose of informing the flight personnel of its possible deterioration, operational control level of the strength of equivalent radiation dose is introduced. The value of operating control of the level for civil aviation air transport is established equal to 10 mrem/hr. When the indicated level is attained, the stations of the Air Traffic Administration (UVD) are informed for the purpose of clearing reserve flight altitudes for possible descent.

5.3. For operating control over the radiation situation for the purpose of preventing disruption radiation safety conditions, the level of strength of equivalent dose of radiation is introduced at which measures are taken (level of taking measures). At this value of strength of equivalent dose, the commander of the air transport must take measures directed at ensuring radiation safety conditions of the flight personnel and passengers (descent to a lower altitude or other measures). The value of the level of taking measures for air transport in civil aviation is set at 50 mrem/hr.

Taking measures directed at ensuring radiation safety conditions is permitted only in case of necessity of preventing an accident or human casualties.

5.4. For flight personnel in the case where the level of radiation effect may exceed 0.3 of the annual maximally allowable dose, i.e., exceed 1.5 rem per year, individual dosimetric control is mandatory. If the level of radiation effect according to the data of physical measurements does not exceed 0.3 of the annual maximum allowable dose, then individual control is not mandatory. In this case, control over the strength of the equivalent dose of radiation is maintained, and the evaluation of individual doses is performed according to these data.

5.5. The results of all types of radiation control on board air transport must be registered. In performing individual dosimetric control of the flight personnel, it is necessary to keep an accounting of the equivalent /12 dose per year, as well as for the entire period of occupational activity.

5.6. If necessary, the levels of radiation effect on air transport passengers during the flight are determined according to the readings of on-board dosimetric apparatus.

5.7. The on-board dosimetric apparatus must ensure obtaining values of strength of equivalent dose in units of rem/hr (millirem/hr), with the following radiation components:

-- charged particles;

-- neutrons;

-- gamma-radiation;

as well indication (signalling devices) of the levels of strength of equivalent dose, equal to 10 mrem/hr and 50 mrem/hr.

5.8. With the effect of radiation of mixed composition with known content of individual components, the value of the strength of equivalent dose is determined as the sum of values of strength of equivalent dose of the individual components.

5.9. In determining the equivalent dose of various types of ionizing radiation with unknown spectral composition, it is necessary to use the quality coefficient KK, whose values are presented in Table 5.1. For radiation of known spectral composition, it is necessary to use the data presented in Tables 5.2-5.6 in determining the equivalent dose.

Table 5.1 QUALITY COEFFICIENTS OF VARIOUS TYPES OF RADIATION

Type of radiation	KK	Type of radiation	KK
X-ray and gamma-radiation	1	Neutrons with energy below 20 keV	3
Electrons and positrons, beta-radiation	1	Neutrons with energy of 0.1 - 10 MeV	10
Protons with energy less than 10 MeV	10	Alpha-radiation with energy less than 10 MeV	20
		Heavy recoil nuclei	20

Table 5.2 DOSAGE CHARACTERISTICS OF MONOENERGETIC NEUTRONS

Neutron energy E, MeV	Specific maximal equivalent dose, rem·cm^2/neutron	Quality coefficient, KK
тепловые	$1{,}0 \times 10^{-9}$	2,8
1×10^{-7}	$1{,}0 \times 10^{-9}$	2,8
$1 \times 10^{-6} \div 1.10^{-4}$	$2{,}1 \times 10^{-9}$	2,8
5×10^{-3}	$1{,}6 \times 10^{-9}$	2,5
2×10^{-2}	$1{,}7 \times 10^{-9}$	2,7
1×10^{-1}	$8{,}6 \times 10^{-9}$	9,0
5×10^{-1}	$5{,}0 \times 10^{-8}$	12
1×10^{0}	$4{,}1 \times 10^{-8}$	12
$2{,}5 \times 10^{0}$	$5{,}0 \times 10^{-8}$	10
5×10^{0}	$5{,}1 \times 10^{-8}$	8,4
[illegible] $\times 10^{1}$	$5{,}0 \times 10^{-8}$	6,7
[illegible] $\times 10^{1}$	$6{,}3 \times 10^{-8}$	8,0
1×10^{2}	$5{,}0 \times 10^{-8}$	4,0
5×10^{2}	$6{,}2 \times 10^{-8}$	3,0
1×10^{3}	$1{,}2 \times 10^{-7}$	2,5
1×10^{4}	$3{,}3 \times 10^{-7}$	2,5
1×10^{5}	$6{,}0 \times 10^{-7}$	2,5
1×10^{6}	$8{,}5 \times 10^{-7}$	2,5

Table 5.3. DOSAGE CHARACTERISTICS OF MONOENERGETIC PROTONS

Proton energy, MeV	Specific maximal equivalent dose, rem·cm^2/proton	Quality coefficient, KK
2×10^0	$1{,}7 \times 10^{-4}$	13,5
5×10^0	1×10^{-4}	11,7
1×10^1	6×10^{-5}	9,4
2×10^1	$4{,}5 \times 10^{-5}$	7,0
5×10^1	$8{,}5 \times 10^{-6}$	4,7
1×10^2	$2{,}5 \times 10^{-6}$	3,4
2×10^2	$3{,}0 \times 10^{-7}$	2,4
5×10^2	$1{,}2 \times 10^{-7}$	2,1
1×10^3	$1{,}4 \times 10^{-7}$	2,1
3×10^3	$2{,}5 \times 10^{-7}$	2,2
1×10^4	$3{,}7 \times 10^{-7}$	2,3
3×10^4	$4{,}9 \times 10^{-7}$	2,3
1×10^5	$6{,}3 \times 10^{-7}$	2,4
3×10^5	$7{,}5 \times 10^{-7}$	2,4
1×10^6	$8{,}8 \times 10^{-7}$	2,3

Table 5.4. FLOW DENSITY OF NEAVY NUCLEI CREATING STRENGTH OF EQUIVALENT DOSE OF 2.5 mrem/hr, part/cm^2 x sec.

Nucleus / Nuclear energy, MeV/nuclon	${}^{4}_{2}He$	${}^{9}_{4}Be$	${}^{14}_{7}N$	${}^{28}_{14}Si$	${}^{56}_{26}Fe$
2×10^0	$9{,}2 \times 10^{-4}$	$3{,}5 \times 10^{-4}$	—	—	—
5×10^0	$1{,}2 \times 10^{-3}$	$3{,}8 \times 10^{-4}$	$1{,}7 \times 10^{-4}$	$8{,}7 \times 10^{-5}$	—
1×10^1	$2{,}0 \times 10^{-3}$	$4{,}5 \times 10^{-4}$	$2{,}1 \times 10^{-4}$	$9{,}7 \times 10^{-5}$	$5{,}0 \times 10^{-5}$
2×10^1	$3{,}7 \times 10^{-3}$	$6{,}2 \times 10^{-4}$	$2{,}4 \times 10^{-4}$	$1{,}0 \times 10^{-4}$	$5{,}0 \times 10^{-5}$
5×10^1	$1{,}1 \times 10^{-2}$	$1{,}2 \times 10^{-3}$	$3{,}7 \times 10^{-4}$	$1{,}1 \times 10^{-4}$	$5{,}2 \times 10^{-5}$
1×10^2	$3{,}2 \times 10^{-2}$	$2{,}5 \times 10^{-3}$	$6{,}5 \times 10^{-4}$	$1{,}6 \times 10^{-4}$	$6{,}0 \times 10^{-5}$
2×10^2	$8{,}0 \times 10^{-2}$	$8{,}5 \times 10^{-3}$	$1{,}9 \times 10^{-3}$	$2{,}5 \times 10^{-4}$	$7{,}7 \times 10^{-5}$
5×10^2	—	$5{,}7 \times 10^{-1}$	$2{,}0 \times 10^{-3}$	$7{,}0 \times 10^{-4}$	$2{,}2 \times 10^{-4}$
1×10^3	—	$5{,}7 \times 10^{-1}$	$1{,}3 \times 10^{-1}$	$1{,}1 \times 10^{-2}$	$4{,}5 \times 10^{-4}$
2×10^3	—	$4{,}7 \times 10^{-1}$	$1{,}5 \times 10^{-1}$	$1{,}2 \times 10^{-2}$	$1{,}7 \times 10^{-3}$
5×10^3	—	$3{,}5 \times 10^{-1}$	$1{,}5 \times 10^{-1}$	$1{,}2 \times 10^{-2}$	$2{,}0 \times 10^{-3}$
1×10^4	—	$2{,}5 \times 10^{-1}$	$1{,}4 \times 10^{-1}$	$1{,}2 \times 10^{-2}$	$1{,}7 \times 10^{-3}$

Table 5.5. DOSAGE CHARACTERISTICS OF MONOENERGETIC -MESONS

Energy of π-mesons, MeV	Specific maximal equivalent dose, rem·cm^2/meson		Quality coefficient, KK	
	$\pi+$	$\pi-$	$\pi+$	$\pi-$
1×10^1	$3,9 \times 10^{-7}$	$6,8 \times 10^{-6}$	1,2	9,1
2×10^1	$2,9 \times 10^{-7}$	$6,8 \times 10^{-6}$	1,1	10,2
5×10^1	$2,6 \times 10^{-7}$	$6,0 \times 10^{-6}$	1,2	10,5
1×10^2	$3,0 \times 10^{-7}$	—	2,0	5,0
2×10^2	$1,6 \times 10^{-7}$	$1,8 \times 10^{-7}$	2,2	3,0
5×10^2	$1,6 \times 10^{-7}$	$1,6 \times 10^{-7}$	2,3	2,6
1×10^3	$1,9 \times 10^{-7}$	$1,9 \times 10^{-7}$	2,3	2,4
2×10^3	$2,0 \times 10^{-7}$	$2,0 \times 10^{-7}$	2,3	2,3
1×10^4	$3,2 \times 10^{-7}$			
2×10^4	$3,5 \times 10^{-7}$			
5×10^4	$4,2 \times 10^{-7}$			
1×10^5	$4,8 \times 10^{-7}$			
2×10^5	$5,2 \times 10^{-7}$			
5×10^5	$6,0 \times 10^{-7}$			
1×10^6	$7,0 \times 10^{-7}$			
2×10^6	$7,8 \times 10^{-7}$			
5×10^6	$9,6 \times 10^{-7}$			

Table 5.6. DOSAGE CHARACTERISTICS OF MONOENERGETIC MUONS

Energy of muons, MeV	Specific maximal equivalent dose, rem·cm^2/muon
5×10^2	$3,3 \times 10^{-8}$
1×10^3	$3,6 \times 10^{-8}$
2×10^3	$3,6 \times 10^{-8}$
5×10^3	$3,7 \times 10^{-8}$
1×10^4	$3,8 \times 10^{-8}$
2×10^4	$3,8 \times 10^{-8}$
5×10^4	$4,0 \times 10^{-8}$
1×10^5	$4,2 \times 10^{-8}$
2×10^5	$4,6 \times 10^{-8}$
5×10^5	$6,0 \times 10^{-8}$
1×10^6	$9,5 \times 10^{-8}$

6. CONCLUSION

6.1. Time of introduction.

These standards for radiation safety of flight personnel and passengers of civil aviation air transport are effective as of 01/01/1976. /16

6.2. Time of effectiveness.

These standards for radiation safety are being put into effect for the period from 01/01/1976 to 01/01/1979, with subsequent updating by permanent standards.